PATENT SPECIFICATION

(11) 1 561 857

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(21) Application No. 4693/77 (22) Filed 4 Feb. 1977 (19)
(31) Convention Application No. 67413 (32) Filed 24 Feb. 1976 in
(33) Italy (IT)
(44) Complete Specification published 5 March 1980
(51) INT. CL.³ F16D 43/10
(52) Index at acceptance
F2C 1C1A 1C9A6 1C9B2

(54) CENTRIFUGAL FRICTION CLUTCH

(71) We, FIAT SOCIETA PER AZIONI, an Italian joint stock company, of Corso Marconi 10, Turin, Italy, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

The present invention relates to centrifugal friction clutches.

It is known to provide motor vehicles with centrifugal friction clutches for the purpose of transmitting the driving torque developed by an internal combustion engine to the half-shafts of the vehicle, through a speed change gear interposed between a shaft driven directly from the vehicle clutch and a transmission shaft connected to the differential gear.

Such centrifugal clutches have, however, some practical disadvantages in operation, particularly as regards slight slipping in the transmission of the driving torque, which prevents the efficient utilization of the full torque of the engine at low rotational speeds. In order to limit such slipping it is necessary to determine experimentally, according to the characteristics of the engine and of the vehicle, the most suitable speeds for engagement and disengagement of the clutch.

The aforesaid clutch slip also renders it impossible to use a high gear ratio at low engine speeds, and this leads to a considerable waste of fuel.

The object of the present invention is to avoid the above-mentioned disadvantages in a centrifugal friction clutch, by providing a clutch having a differential clutching action, that is, a clutch which disengages, upon decrease in engine speed, at a lower engine speed than that at which the clutch fully engages upon increasing speed on starting.

According to the invention there is provided a centrifugal friction clutch comprising a clutch housing, means for coupling the housing to a rotatable part of an engine such as a flywheel so as to be rotatable therewith, a pressure plate within the housing and coupled thereto so as to be rotatable with the housing and axially slidable relative to said housing, a drive disc disposed on one side of said pressure plate so as to be interposed between the rotatable engine part and the pressure plate said drive disc being adapted for mounting on so as to be rotatable with an output drive shaft driven by the clutch, friction elements on opposite sides of the drive disc, de-clutching spring means biasing the pressure plate towards the housing, centrifugal masses interposed between the housing and the pressure plate and radially extending cam tracks along which the centrifugal masses are centrifugally movable upon rotation of the rotatable engine part in use of the clutch each cam track having a radially inner and a radially outer portion, the outer portion being inclined at a shallower angle to the radial direction than the inner portion such that said masses exert different axial reaction loads against elastic means biasing the the centrifugal masses, at different radial positions of the centrifugal masses on the cam tracks.

The clutch according to the invention, once engaged, is able to transmit the full torque of the engine to which it is connected down to a lower rotational speed than the speed at which the clutch becomes fully engaged, thus giving a differential clutching action.

The clutch according to the invention also has the advantage of reducing slip in the transmission of inertial torque from the wheels to the engine in engine braking conditions at low engine speeds.

The maximum value of the transmissible torque is determined by the load of the elastic means, which would preferably be arranged to limit this torque to a definite value, slightly higher than the maximum torque developed by the engine.

The pressure plate is preferably provided with the cam tracks upon which the centrifugal masses move.

The invention will be further understood

from the description which follows, by way of non-limiting example, with reference to the accompanying drawings, in which:

Figure 1 is a transverse section of a traditional centrifugal friction clutch of the known prior art;

Figures 2, 3 and 4 are transverse sections, corresponding to Figure 1, of a centrifugal clutch according to one embodiment of the invention in different working stages;

Figure 5 is a sectional view of a centrifugal mass of the clutch of Figures 2, 3 and 4; and

Figures 6 and 7 are graphical diagrams which illustrate respectively characteristic operating curves of a prior art centrifugal friction clutch and a friction clutch according to the invention.

The same reference numerals are used throughout the drawings to designate the same or corresponding components.

With reference to Figure 1, part of a traditional centrifugal friction clutch according to the prior art is illustrated in axial section. The clutch is mounted on one side of a rotary flywheel 1 coupled to the crankshaft of an internal combustion engine (not shown). The clutch has friction elements comprising two annular friction discs 2, 3 of synthetic material between which a flat metal drive disc 4 is interposed, the disc 4 being coupled through a sleeve 5 to a drive shaft 6 which is connected through a gearbox (not shown) to a drive transmission shaft of a vehicle. An annular pressure plate 7 is mounted within a rotary clutch housing 13 which is rotatable with the flywheel 1. The plate 7 is spaced from the engine flywheel 1 and also, when the engine is stationary, from the friction disc 3, the plate 7 being rotatable with the housing 13 and urged towards the housing 13 by a series of helical de-clutching springs 11 distributed around the shaft 6.

A number of centrifugal masses 18, one only of which is shown, are positioned between a frusto-conical internal surface of the housing 13 and the pressure plate 7, each mass 18 being movable radially in a respective radial guide channel 23 in the pressure plate 7 and having a cylindrical bearing portion 21 which rolls upon a radial face of the plate 7 disposed in a plane perpendicular to the axis of the shaft 6.

Upon rotation of the engine flywheel 1 the clutch housing 13 and pressure plate 7 rotate, carrying with them the centrifugal masses 18, which move radially outwardly under centrifugal force, causing, by a camming action, axial displacement of the pressure plate 7 away from the housing 13 and against the biasing force of the de-clutching springs 11 so as to press the friction discs 2, 3 into frictional engagement with the disc 4 to establish a drive coupling between the flywheel 1 and the shaft 6.

Figure 2 illustrates the construction of a clutch according to this invention. Reference numeral 1 indicates a flywheel attached to the crankshaft of an internal combustion engine (not shown). The clutch has a drive disc 4 provided on opposite sides with annular discs 2, 3 respectively of a known synthetic material. The friction disc 2 faces a flat annular face provided on the flywheel. The disc 4 is connected through a sleeve 5 to a drive shaft 6 driven through the clutch by the engine. This connection is affected by means of rivets 8 passing through radial slots *5a* in an annular plate *5b*, the rivets 8 having heads at opposite ends supported by respective sheet metal annular plates 9 and 10 disposed one on either side of the plate *5b*. A clutch pressure plate 7 is spaced from the engine flywheel 1 and also, when the engine is stationary, from the friction disc 3, by means of a series of helical de-clutching springs 11, located in this case radially outwardly of the circumference of the drive disc 4, which bias the pressure plate 7 towards the clutch housing 13. Respective pins 12 pass through the springs 11 and are attached to the clutch housing 13 for the purpose of accurately locating the springs 11.

A reaction plate 15 is secured within the housing 13 by means of rivets 14 and is maintained spaced from the housing 13 by elastic biasing means in the form of helical springs 16. The plate 15 has a radial wall 17 facing the pressure plate 7. A number of centrifugal masses 18 rest upon the radial wall 17. At the radially inner limit of their movement the masses 18 bear against a ring 19 of elastomeric material on the plate 15 which serves a damping function.

The centrifugal masses 18 (Figure 5) are each formed by a pair of rollers 20 keyed to a shaft 22 with the interposition between them of a rolling bearing portion 21 rotatably mounted on the shaft 22. The masses 18 are guided for centrifugal movement in guide channels 23 extending radially in the pressure plate 7. The pressure plate 7 is also provided with raised cam tracks 24 between the guide channels 23 upon which the bearing portions 21 of the masses 18 roll. The radially outward movement of the masses 18 is limited by stop pads 25 attached to the inside wall 26 of the housing 13.

It will be noted that compared with the comparable known centrifugal clutch illustrated in Figure 1 the clutch of the present invention is provided with the springs 16, the reaction plate 15, and a pressure plate 7 of different shape provided with cam tracks 24 of a particular conformation. For ease of manufacture the cam tracks 24

could be provided on the reaction plate 15 instead of on the pressure plate 7.

Figure 6 and 7 are graphical plots of the rotational speed of the engine, represented as the number of revolutions n of the engine per minute (abscissa axis) against the values of the transmitted driving torque M of the clutch in Kgm (ordinate axis), Figure 6 relating to a traditional clutch of the prior art and Figure 7 to a clutch according to this invention.

Figure 6 shows diagrammatically the operating characteristics of a traditional centrifugal clutch such as that of Figure 1. In this case the transmitted torque M upon increasing engine speed is represented by the ascending curve A, and the transmitted torque corresponding to decreasing engine speed is represented by the descending curve B. Between the two curves A and B there is a small difference or hysteresis zone Z due to the inevitable friction between the various relatively movable parts of the clutch. The engine rotational speeds n_1 and n_2 at the start and finish respectively of the clutching operation, determined experimentally as a function of the characteristics of the engine and of the vehicle, are typically as follows:

n_1 = 900–1000 revolutions per minute, this being a speed such that the engine torque can pull the vehicle upon engaging the clutch;

n_2 = 1,500–2,200 revolutions per minute, selected so as to make the clutch engagement gentle and gradual in parking manoeuvres, taking also into account the characteristcs of flexibility of the engine.

From Figure 6 it is evident that the full torque developed by the engine (curve T) cannot be utilized much below the speed n_2 without clutch slip, indicated by the shaded zone C in Figure 6. The clutch cannot therefore be used to transmit the available torque T of the engine at low rotational speeds between n_1 and n_2 without substantial clutch slip occurring.

Referring to Figure 7, the clutch according to the invention operates as follows. With the engine stationary or running at a low speed, that is at a speed lower than n_1 (Figure 7), the de-clutching springs 11 keep the pressure plate 7 spaced from the friction disc 3, which is therefore able to rotate freely. This de-clutched condition is illustrated in Figure 2, in which the transmitted torque M is zero up to the rotational speed n_1.

Upon increase in the engine speed beyond n_1 the centrifugal force Fc of the masses 18 (Figure 3) increases and consequently the axial component of force Fa exerted by the masses 18 against the plate 15 increases as the masses move radially outwardly over the cam tracks 24, opposing the load of the springs 11 and displacing the pressure plate 7 axially against the friction disc 3. Torque transmission by the clutch device then begins, increasing as a quadratic function of the engine rotational speed n, according to the ascending curve A in Figure 7.

When the engine reaches the speed n_2 the axial force component Fa equals the force exerted by the springs 16 (point D in Figure 7) which in turn preload the reaction plate 15, kept in position by the rivets 14. Consequently upon further increase in the engine speed, the masses 18 move radially outwardly, moving the reaction plate 15 towards the right, as viewed in Figure 2, until the masses 18 bear against the stop pads 25 (Figure 4). During this movement the masses 18 pass from radially inner portions of the cam tracks 24, having an angle of inclination α (Figure 3) to the radial direction, to radially outer portions of the tracks 24 having a smaller angle of inclination β to the radial direction (Figure 4).

For a given centrifugal force component Fc on each centrifugal mass (Figures 3 and 4) the reduction of the cam track angle from α to β results in an increased axial force compenent Fa, as illustrated in Figure 4, which reaches equilibrium with the load of the springs 16 at a much lower engine speed, so that, when the rotational speed of the engine falls the transmitted torque M follows the descending curve B until the point E is reached, close to the engine speed n_1, below which the transmitted torque M again drops to zero. The area C beneath the engine torque curve T and between the two curves A and B, shown shaded, represents a low-speed operating region in which the full engine torque can be transmitted substantially without slip.

A further advantage of the clutch according to the invention is its universality of application. Thus, the invention is not confined to the motor car field, but can also be extended to drive transmissions for fixed engine installations in which a gradual and controlled low speed drive is required, such as, for example, digging or earth moving machines and lifts in buildings.

It will be understood that practical embodiments of the invention and details of construction can be widely varied with respect to the embodiment which has been described and illustrated, without departing from the scope of the present invention.

WHAT WE CLAIM IS:—

1. A centrifugal friction clutch comprising a clutch housing, means for coupling the housing to a rotatable part of an engine such as a flywheel so as to be rotatable therewith, a pressure plate within the housing and coupled thereto so as to be rotatable with the housing and axially slidable rela-

tive to said housing, a drive disc disposed on one side of said pressure plate so as to be interposed between the rotatable engine part and the pressure plate said drive disc being adapted for mounting on so as to be rotatable with an output drive shaft driven by the clutch, friction elements on opposite sides of the drive disc, de-clutching spring means biasing the pressure plate towards the housing, centrifugal masses interposed between the housing and the pressure plate and radially extending cam tracks along which the centrifugal masses are centrifugally movable upon rotation of the rotatable engine part in use of the clutch each cam track having a radially inner and a radially outer portion, the outer portion being inclined at a shallower angle to the radial direction than the inner portion such that said masses exert different axial reaction loads against elastic means biassing the centrifugal masses, at different radial positions of the centrifugal masses on the cam tracks.

2. A friction clutch according to Claim 1, wherein the pressure plate is provided with the cam tracks.

3. A friction clutch according to Claim 1 or 2 in which a reaction plate is preloaded by the elastic means and connected to the clutch housing, the centrifugal masses being interposed between the pressure plate and the said reaction plate.

4. A friction clutch according to any one of Claims 1 to 3, in which the housing has an internal circumferential wall provided with limit stops for limiting the radial displacement of the centrifugal masses.

5. A friction clutch according to any one of the preceding claims, in which the de-clutching spring means act upon a peripheral portion of the pressure plate radially outwardly of the friction elements.

6. A friction clutch according to Claim 4, in which the de-clutching spring means are arranged to react against the rotatable engine part in use of the clutch, urging the peripheral portion of the pressure plate against the clutch housing.

7. A centrifugal friction clutch substantially as herein described with reference to and as shown in Figures 2 to 5 and 7 of the accompanying drawings.

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1980.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY
from which copies may be obtained.

FIG. 1

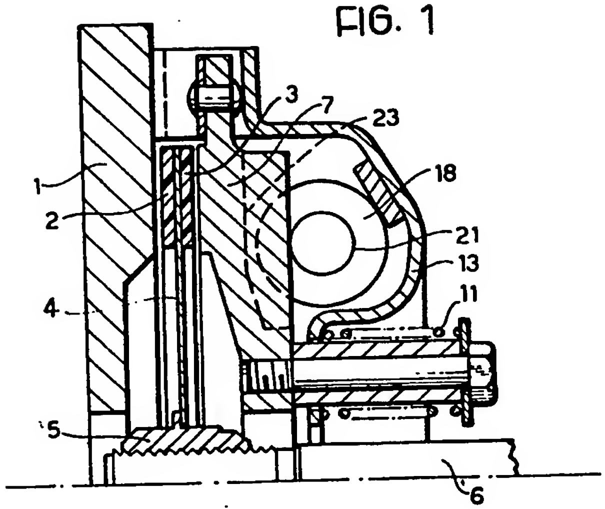
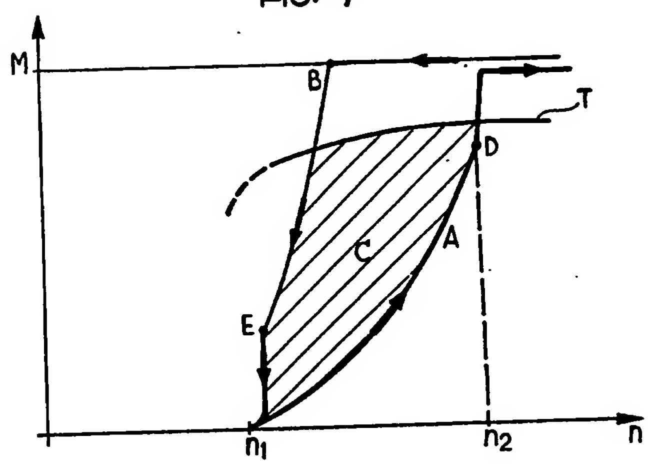


FIG. 7



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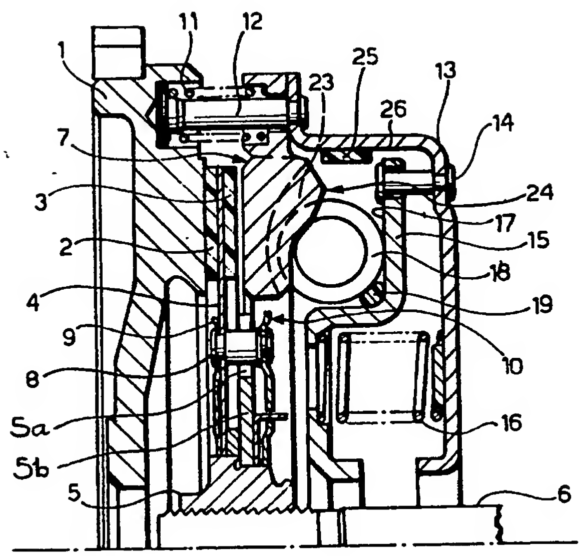
Sheet 2

FIG. 2



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Sheet 3

FIG. 3

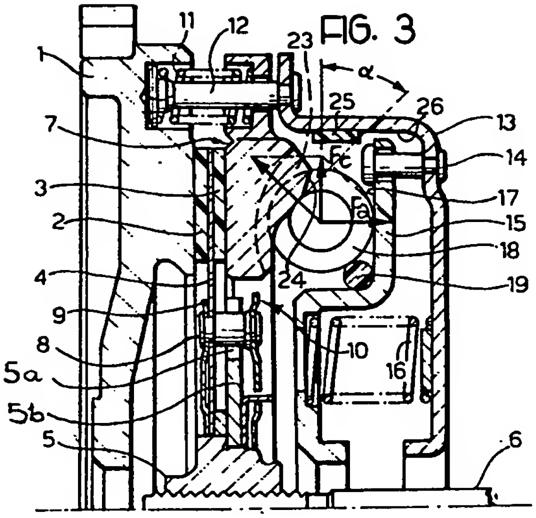

FIG. 4

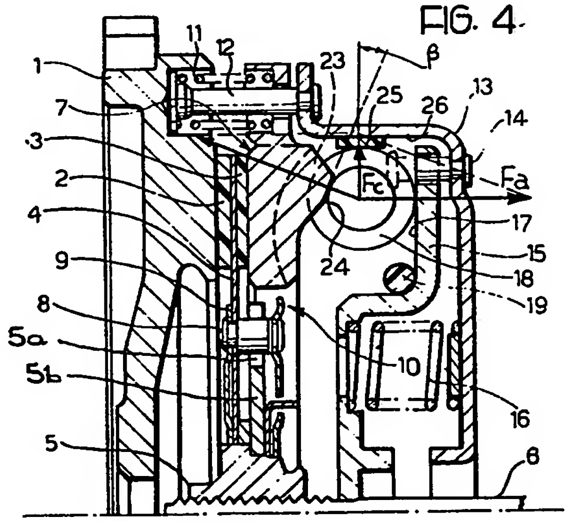

FIG. 5

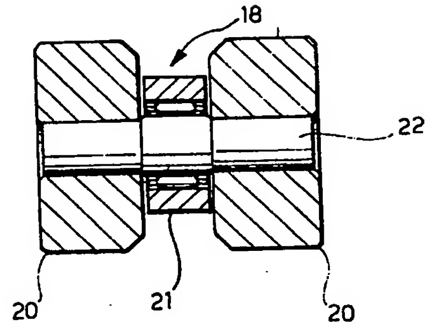

FIG. 6